Ecography

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Supplementary material

Table S1. List of plant species (in transects) belonging to the diet of at least one focal bird species. For each combination plant species-focal bird species, we indicated: 0 – fruit probably not used (based on habitat use and foraging behaviour of the bird, as well as on fruit characteristics such as type, colour and size); 1 – personal observation of feeding events in the study area; 2 – evidence of feeding events from these or closely related bird species from literature (Dowsett-Lemaire 1988, Bleher 2000 and Githiru et al. 2002); 3 – feeding not recorded but reasonable to assume that fruits are eaten (based on plant, fruit and bird characteristics).

Plant species	Growth form	*A. milanjensis*	*Z. silvanus*	*T. hartlaubi*	*C. brevis*
Agelaea pentagyna	liana/shrub	1	3	3	1
Allophylus sp.*	tree	1, 2	1, 2	1, 2	1
Asparagus africana	liana	1	3	3	0
Asparagus asparagoides	liana	3	3	3	0
Asparagus setaceus	liana	3	3	3	0
Brucea antidysenterica	shrub/tree	1	3	3	3
Camphora chinensis	tree	1	1	1	3
*Canthium oligocarpum**	shrub/tree	1	2, 3	2	2, 3
Chassalia discolor	shrub	1	3	3	0
Chassalia parvifolia	shrub	1	3	3	0
Cissus oliverum	liana	1	3	3	3
*Clerodendrum johnstonii**	liana	2, 3	3	2, 3	3
*Cola greenwayi**	tree	3	0	2, 3	3
Culcasia scandens	liana	1	3	3	0
Cussonia spicata	tree	1	1	1	1
*Dracaena steudneri**	shrub	1, 2	3	2, 3	0
*Ekebergia capensis**	tree	3	3	2, 3	3
Ficus sur	tree	1	3	3	3
Ficus thoningii	tree	1	1	1	1
*Keetia gueinzii**	liana/shrub	3	3	3	0
*Lantana camara**	shrub	1	3	3	0
*Lasianthus kilimandscharicus**	shrub	1	3	3	0
Lepidotrichilia volkensii	shrub/tree	1	1	1	3
Leptonychia usambarensis	tree	1	3	1	3
Maesa lanceolata	tree	1, 2	1, 2	1, 2	1
Maesopsis eminii	tree	1	1	1	1
Neoboutonia sp./ *Macaranga* sp.	tree	1	1	3	3
Oxyanthus speciosus	tree	3	3	3	3
Pauridianthus paucinervis	shrub	1	1	3	0
Phoenix reclinata	tree	1	1	1	3
Prunus africana	tree	1, 2	1, 2	1, 2	1
Psychotria crassipetala	shrub/tree	3	3	2, 3	0
Psychotria lauracea	herb	1	3	2, 3	0
Psychotria petitii	shrub/tree	3	3	2, 3	0
Psychotria pseudoplatyphylla	shrub/tree	1	3	1, 2	0
Psychotria sp.	shrub	3	3	2, 3	0

Rapanea melanophloeos	tree	1, 2	1, 2	1, 2	3
Rauvolfia mannii	shrub	1	3	2, 3	0
Rourea thomsonii	liana/tree	1	3	3	1
Rubus sp.*	herb	1	3	1	0
Rytigynia eickii	shrub	1	3	3	0
Rytigynia uhligii	shrub	1	3	3	0
Solanum schumanniana	shrub	3	3	3	0
sp. A	shrub	1	3	3	3
Syzigium sclerophyllum	tree	1	3	2, 3	1
*Teclea nobilis**	tree	3	3	3	3
*Teclea simplicifolia**	tree	3	3	3	3
*Toddalia asiatica**	liana	3	3	3	0
Trema orientalis	tree	1	1	1	3
Turraea holstii	shrub/tree	1	3	3	3
*Vitex keniensis**	tree	1	1	3	3
Xymalos monospora	tree	1, 2	1, 2	1, 2	1, 2

*: Species present in transects but never observed with ripe fruits in these transects during the study period, and thus not used in analyses.

References

Dowsett-Lemaire, F. 1988. Fruit choice and seed dissimination by birds and mammals in the evergreen forests of upland Malawi. – Rev. Ecol. (Terre et vie) 43: 251–285.

Bleher, B. 2000. Seed dispersal and frugivory: ecological consequences for tree populations and bird communities. – Ph.D. thesis, RWTH Aachen, <http://sylvester.bth.rwth-aachen.de/dissertationen/2000/39/00_39.pdf>.

Githiru, M. et al. 2002. Effects of site and fruit size on the composition of avian frugivore assemblages in a fragmented Afrotropical forest. – Oikos 96: 320–330.

Table S2. Distance between the centre of the study-plots (in metres).

	CHA1	CHA2	CHA4	NGA3	NGA5	NGA6	FUR	YAL	MAC	MWA	WUN
CHA1	0	300	700	13300	14000	11950	5300	8700	6850	7500	9050
CHA2		0	450	13600	14250	12250	5600	9000	7050	7700	9300
CHA4			0	13950	14600	12500	5950	9350	7350	7950	9600
NGA3				0	700	1400	8050	4850	7150	7300	5100
NGA5					0	2100	8700	5450	7850	8000	5700
NGA6						0	6600	3600	5800	6000	3800
FUR							0	3450	2750	3800	4300
YAL								0	4000	4700	3300
MAC									0	1050	2350
MWA										0	2300
WUN											0

Table S3. Details of the detection function options used for the estimation of bird distances in the program Distance v5.0 beta 5 (Thomas et al. 2006). Distance intervals are mostly narrower close to zero (hence "unequal" groups) to improve fit (Buckland et al. 2001).

Species	Detection function	Grouping	Truncation distance (m)	Model
A. milanjensis	global; MCDS with plot as covariable	9 unequal groups	35	halfnormal + simple polynomial
Z. silvanus	global	7 unequal groups	25	halfnormal + cosine
C. brevis	global	8 unequal groups	35	uniform + cosine
T. hartlaubi	global	7 unequal groups	35	halfnormal
P. stellata	global	8 unequal groups	30	uniform + cossine
C. olivacea	global	8 unequal groups	30	halfnormal + cosine
P. ruficapillus	global; MCDS with plot as covariable	7 equal groups	35	hazard-rate + cosine
P. placidus	global	9 unequal groups	35	uniform + cosine

MCDS: multiple covariate distance sampling (see Marques et al. 2007 for details).

References

Buckland, S. T. et al. (eds) 2001. *Introduction to distance sampling.* – Oxford Univ. Press.
Marques, T. A. et al. 2007. Improving estimates of bird density using multiple covariate distance sampling. – Auk 124: 1229–1243.
Thomas, L. et al. 2006. Distance 5.0. Release beta 5. – Research Unit for Wildlife Population Assessment, Univ. of St. Andrews, UK, <http://www.ruwpa.st-and.ac.uk/distance/>.

Appendix S4. Bird movements – methodological details and results

Methods

Avian movements were studied in one small forest fragment (MAC, 3 ha indigenous forest; 25 ha including exotic stands), one intermediate-sized fragment (CHA, 90 ha; 95 ha) and one large fragment (NGA, 133 ha; 161 ha). In each fragment, individuals of the three study species were captured with standard mist-nets during Jul–Sep 2005 and 2006. Upon capture, each bird was weighed, measured and banded with a steel numbered band and a unique combination of colour bands. A total of 30 adult *A. milanjensis* (four in CHA, 12 in MAC, 14 in NGA) were fitted with lightweight radio-transmitters (Biotrack) attached with superglue onto the interscapular area (Sykes et al. 1990). Additionally, two *T. hartlaubi* (one in MAC, one in NGA) were provided with a tail-mounted TW-4 transmitter sewn to the bird's rectrices (Kenward 2001). Each transmitter weighed <2.5% of the species' mean body mass, which is less than half the threshold value proposed by Kenward (2001). Apart from a temporary increase in preening behaviour during the first hours after release, tagged individuals behaved, flew and fed normally, and individuals recaptured during or immediately after tagging did not lose weight and remained in good body condition. To allow habituation to the transmitter, individuals were not tracked during the first 24 h after release.

We used portable TR-4 receivers (Telonics, Mesa, AZ) and 3-element flexible Yaggi antennas (Biotrack) to track individuals simultaneously in the three forest fragments, daily between 06.30 and 18.30. Because long-distance triangulation is inaccurate in hilly terrain and does not allow behavioural observations, individuals were followed at close range (ca 10 m; homing-method sensu Millspaugh and Marzluff 2000) without disturbing their natural behaviour. Every fifth minute, GPS location (Garmin 60CSX; accuracy 5–15 m), habitat type (indigenous forest, exotic plantation, farmland) and behaviour (resting, preening, feeding, moving) were recorded. Both in 2005 and 2006, individuals were observed for an average of 30 h over ca 20 d in a fully randomized order. Distances and habitat use recorded did not differ when birds were tracked before 11.00, between 11.00 and 15.00, or after 15.00 during the course of an observation day (*A. milanjensis*: $F_{2, 574} = 1.40$, $p = 0.25$; *T. hartlaubi*: $F_{2, 134} = 1.97$, $p = 0.14$).

Results

Daily movement distances were 255 ± 10 m and 161 ± 49 m for *T. hartlaubi* and *A. milanjensis* respectively.

Radio-tagged individuals of *T. hartlaubi* and *A. milanjensis* regularly visited farmland and plantations bordering indigenous forest fragments. Both tagged individuals of *T. hartlaubi* visited exotic plantations and isolated trees in the farmland for nearly half of the time observed (% plantation ± SE: 15.37 ± 8.29, farmland: 30.39 ± 0.94, indigenous forest: 54.24 ± 7.35) and were recorded up to 460 m away from indigenous forest edges. More than half of the tagged individuals of *A. milanjensis* were seen at least once in plantation plots or farmland, up to 600 m away from indigenous forest edge. *A. milanjensis* individuals inhabiting the smallest fragment (MAC) spent significantly more time (up to 96.8%) outside indigenous forest than those inhabiting the two larger fragments. In most cases, observations in cultivated area were on isolated fruiting trees, such as *Ficus* sp., *Maesopsis eminii* and *Cinnamom camphora*.

References

Kenward, R. E. 2001. A manual for wildlife radio tagging. – Academic Press.
Millspaugh, J. and Marzluff, J. 2000. Radio tracking and animal populations. – Academic Press.
Sykes, P. W. et al. 1990. Evaluation of 3 miniature radio transmitter attachment methods for small passerines. – Wildl. Soc. Bull. 18: 41–48.